In the present Office Action, (i) the specification was objected to based on a finding of informalities; (ii) Claims 11 and 14 were rejected under 35 U.S.C. §102(b) as being clearly anticipated by Radjai et al ("Effects of Electromagnetic ..."); and (iii) Claims 12 and 13 were rejected under 35 U.S.C. §103(a) as being unpatentable over Radjai et al.

In response to item (i) above, the specification has been amended to correct the noted informalities. Applicants submit that no new matter is introduced.

With respect to items (ii) and (iii) above, Applicants respectfully submit that the present invention, as recited in independent Claim 15 is patentably distinguishable over Radjai et al, based on the following discussion.

Applicants submit that Radjai et al fail to teach or suggest applying a high-energy vibrating force including one of an electromagnetic vibrating force and an ultrasonic vibrating force to metallic material at temperatures lower than a melting point thereof during a solidification process of the molten metallic material to form cavities in the molten metallic material; and crushing into small pieces, via impact pressure generated during collapse of the cavities, solid particles of the metallic material generated during the solidification process to yield a refined microstructure of the metallic material, as recited in independent Claim 15.

Applicants submit that Radjai et al fail to teach or suggest the noted features of the claimed invention.

Applicants submit that in Radjai et al vibrations were induced in a hyper-eutectic Al-Si alloy containing suspended silicon particles and the effects were studied. The mechanism by which vibration brings about micro-structural changes was investigated by interrupting the process at different temperatures before and after the start of solidification through water quenching. Applicants submit that according to Radjai et al "suspended silicon particles [are] multiplied in number with a reduction in size by vibrations at temperatures higher than the

liquidus" and that "[the multiplied particles are] agglomerated and repelled to the outer surface after the start of solidification".

However, Applicants submit that as is apparent from the above-noted teachings, Radjai et al teach a refining technique for crushing silicon particles which are suspended in the molten Al-Si alloy by vibrations at temperatures higher than the liquidus, but teach nothing about a refining technique for crushing materials by vibrations at temperatures lower than the liquidus. According to Radjai et al, suspended silicon particles multiplied in number with a reduction in size by vibrations at temperatures higher than the liquidus and that after the start of solidification, the multiplied particles are agglomerated and repelled to the outer surface.

Accordingly, Applicants submit that Radjai et al fail to teach or suggest applying vibrating force at temperatures lower than the liquids and crushing particles suspended in the molten metal during solidification process, as in the claimed invention. In this respect, Applicants submit that since the phase and property of metallic material is different largely between before and after the solidification thereof, the present invention relating to a refining technique for crushing solid metallic particles generated during solidification process by vibrations at temperatures lower than the liquid is substantially different from a refining technique for crushing particles which is suspended in the molten metal by vibrations at temperatures higher than the liquids as disclosed in Radjai et al.

Applicants submit that Radjai et al fail to teach or suggest the noted features of the claimed invention.

Moreover, as discussed above, Applicants submit that Radjai et al merely teach inducing vibrations in a hyper-eutectic Al-Si alloy containing suspended silicon particles. The Radjai et al reference notes that any two fields alone had no significant effect on a micro-

structure of the alloys, while profound effects were observed when the two fields were applied simultaneously. The Radjai et al reference further noted that suspended silicon particles multiplied in number with a reduction in size by vibrations at temperatures higher than the liquids and agglomerated and repelled to the outer surface after a start of solidification.

However, Applicants submit that Radjai et al merely teach only that Si particles, which are initially crystallized in a hyper-eutectic Al-Si alloy, are multiplied in number with a reduction in size, but fail to teach or suggest refining a micro-structure of other substances suspended in the A1-Si alloy or in a molten alloy metal, as in the claimed invention (see, e.g., page 10, lines 6-14 of Applicants' disclosure). Applicants note that in the Radjai et al reference the hyper-eutectic Al-Si alloy containing suspended silicon particles is directed to a model of Si particles initially crystallized in hyper-eutectic Al-Si alloy. Applicants therefore submit that the Radjai et al reference merely teaches refining a micro-structure of the Si particles in the above specified model (i.e., Si particles initially crystallized in a hyper-eutectic Al-Si alloy) but fails to teach or suggest the noted features of the claimed invention.

The present Office Action asserts that it would have been obvious to use the Radjai et al refining technique in a metal alloy system including metals other than the metal alloy since it would be apparent to those skilled in art that the Radjai et al refining technique will also crush any such other metals. However, Applicants submit that the present Office Action has failed to show substantial evidence of motivation for modifying the Radjai et al refining technique for refining a metal alloy including other metals, as in the presently claimed invention. In Re Gartside, 2000 U.S. App. LEXIS 2065 (CAFC 2000). Applicants submit that Radjai et al is silent with respect to refining a metal alloy including other metals and that

Radjai et al fail to teach or suggest the claimed invention except for a hindsight reconstruction of Applicants' invention based on teachings from Applicants' disclosure.

Applicants respectfully submit that the presently claimed invention advantageously provides an improved micro-structure refining method for other metals contained in a molten alloy metal, as compared to conventional methods (see, e.g., page 10, lines 6-14 of Applicants' disclosure).

Applicants submit that Radjai et al fail to teach or suggest the noted features of the claimed invention.

Accordingly, Applicants submit that (i) it would not have been obvious to one of ordinary skill in the casting art that a solid metallic material can be crushed by vibrations at temperatures lower than the liquidus during the stages of solidification process thereof, as in the claimed invention, (ii) the present inventors have discovered the above-noted features of the presently claimed invention, (iii) Radjai et al do not teach nor suggest such a discovery, and (iv) the presently claimed invention is not obvious over Radjai et al.

Based on the above discussion, Applicants respectfully submit that independent Claim 15 and claims dependent therefrom are patentably distinguishable over Radjai et al.

The present amendment is submitted in accordance with the provisions of 37 C.F.R. §1.116, which after Final Rejection permits entry of amendments placing the claims in better form for consideration on appeal. As the present amendment is believed to overcome outstanding rejections under 35 U.S.C. §§ 102, 103 by clarifying Applicants' invention, the present amendment places the application in better form for consideration on appeal. It is therefore respectfully requested that 37 C.F.R. §1.116 be liberally construed, and that the present amendment be entered.

Consequently, in view of the present amendment, no further issues are believed to be outstanding in the present application. The present application is believed to be in condition for formal allowance. An early and favorable action is therefore respectfully requested.

Respectfully submitted,

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